ABSTRACTS OF PAPERS READ AT THE MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, HELD AT THE STUDENTS' OBSERVATORY, BERKELEY, CAL., ON FRIDAY, APRIL 11, 1913.

Among the papers presented at the April 11th meeting of the Society were eight by advanced students of astronomy in the Lick Observatory and the Students' Observatory at Berkeley. Six of these students—Miss WATERMAN and Miss GLANCY, and Messrs. MERRILL, KIESS, EINARSSON and HAYNES — received the degree of Doctor of Philosophy from the University of California on May 14, 1913. Their papers were the theses they presented in partial fulfillment of the requirements for this degree. Miss KIDDER'S paper was the thesis presented for the degree of M. A., and Mr. LANZENDORF'S the thesis presented for the degree of B. S., awarded at the same commencement. The theses for the doctorate, mentioned above, will be published later in other journals. Abstracts of the eight papers are printed here.

CLASS B STARS WHOSE SPECTRA CONTAIN BRIGHT HYDROGEN LINES.

BY PAUL W. MERRILL,
Fellow in the Lick Observatory, 1910-1913.

The normal or typical stars of Class B show only absorption lines, the characteristic lines being those of helium and hydrogen. There are known, however, nearly seventy that have bright hydrogen lines. The brightest of them, γ *Cassiopeiæ,* was discovered visually by SECCHI in 1866. Most of the other stars have been found photographically by the Harvard College Observatory. Hβ was the bright ray most frequently detected. Ordinary photographic plates are not sensitive to red light, so it remained for CAMPBELL, observing visually with the 36-inch refractor in 1894-5, to find that when Hβ is bright Hα is also bright and stronger. Both bright and dark hydrogen lines

exist in these stars. CAMPBELL formulated the following rules concerning them, which are confirmed by my observations:—

(a) Some stars contain both bright and dark hydrogen lines.

(b) The bright lines in such stars are those of greater wave-length, the dark lines are those of shorter wave-length.

(c) The intensities of the bright lines decrease as we approach the violet.

(d) The intensities of the dark lines increase as we approach the violet.

What actually occurs in most cases is the overlapping of the bright and dark series of lines, each agreeing with rules (c) and (d) respectively. Thus, for instance, we often find $H\beta$ and $H\gamma$ complex, consisting of both bright and dark lines, $H\alpha$ bright without visible absorption, $H\delta$ and succeeding hydrogen lines dark with bright parts very faint if visible at all.

Bright helium lines are also present in a very few of these stars, and a few other bright lines have been noted.

The study of this group of stars made by the writer is largely based on a series of photographs of the red region of their spectra. $H\alpha$ of γ *Cassiopeiæ* was photographed in the second order of a 15,000-line plane grating.

Four new stars of Class B were found to have bright lines, one case having been previously suspected by Miss CANNON. Two of them are *Pleiades* stars, making in all four of that interesting group to show bright lines. One of them, *Pleione,* seems to have recently lost its bright rays. The bright-line stars have a tendency to gather in small groups, i. e. several are often found close together in the sky. In general, the only peculiarities of their distribution are those common to the whole of Class B. A count according to magnitude apparently shows that the brighter stars of Class B have bright lines more frequently than the fainter ones. We may take this to mean that a large star, of great intrinsic luminosity and having intense conditions in its atmosphere, is more apt to emit bright-line radiations than a smaller, weaker star.

In no case are the bright hydrogen lines monochromatic, but are broad or double. This duplicity has been previously noted in a few instances, but my observations show it to be of common occurrence. A large number of the lines are double and the

appearance of the remaining ones is such that it seems probable that all are really double, though not always detected because observed with insufficient dispersion, or because the components are broad and hazy and run together. Hα is seldom seen double, doubtless due to the causes just mentioned. In ε *Capricorni* the components of Hα stand clearly apart, with a separation of seven Ångstroms. The grating spectrograms of γ *Cassiopeiæ* give an intensity curve for Hα that probably indicates two blended components, their centers being about three Ångstroms apart. Of the other hydrogen lines the average separations are:

Bβ	(21 stars)	3.5 Ångstroms
Hγ	(8 ")	2.6 "
Hδ	(2 ")	2.2 "

In the individual stars there are large variations from these numbers and from their ratios. There seem to be no consistent relations such as those of Doppler or Zeeman effect.

The components of the bright lines do not unite as they would if due to a pair of revolving bodies, within any period of the order of length of the periods of spectroscopic binaries of Class B. They stand apart for months and years, and apparently permanently, at about the same separation.

The bright components of Hβ, of b² *Cygni*, and γ *Cassiopeiæ* were tested for polarization. The results were in general negative, i. e. no large proportion of the light is polarized. However, one plate of each star gave slight indications of plane polarization of the outside edges of the double lines.

Complex self-reversal, similar to the self-reversal of the electric arc, is favored as an explanation for the observed lines. There is the negative argument that no other explanation seems at all satisfactory. The positive evidence may be briefly stated as follows:—

The appearance of many of the lines suggests self-reversal;

The separations of the bright portions are about what one might expect under this hypothesis;

The bright lines occur in stars with hot extensive atmospheres, and probably more often in stars larger than the average;

There are qualitatively similar reversals in the Sun.

D_3 of γ *Cassiopeiæ* appears on my plates as a very faint bright line. To be seen visually, as it has been in the past, it would have to be considerably stronger. In about a dozen stars several enhanced metallic lines show bright. ϕ *Persei* is the best example found. The lines of this star correspond closely to the strongest lines of the solar chromosphere, with the exception of the lines of magnesium, sodium, and helium. The lines of sodium and helium are dark in ϕ *Persei,* and magnesium is not represented at all. Many of the bright lines are double. That the lines of the atmosphere of a solar star should be present in the spectra of Class B stars argues for the unity of the stellar system.

In order to trace evolutionary relationships we should have an extensive series of observations of stars beginning with the Wolf-Rayet type and extending through the late subdivisions of Class O up to Class B; and, again, observations of numerous objects of Classes A and F, since there are stars classified from Bo to Fo which have bright lines.

THE CLUSTER VARIABLE RR *LYRÆ*.

By C. C. Kiess,
Fellow in the Lick Observatory, 1910-1913.

In a previous article, appearing in this journal for August, 1912, the writer has attempted to give an account of the general features and characteristics of the cluster variables, and also some theories which have been put forth in explanation of this peculiar type of variation. Of the isolated cluster variables, the brightest one so far as known is RR *Lyræ,* which at maximum is of magnitude 7.0 and at minimum of magnitude 7.8. This star has been observed both photometrically and spectrographically at the Lick Observatory during the summer and autumn months of 1912. Credit is due to Dr. S. D. Townley for making a number of the earlier photometric observations. All the other observations of the star, photometric and spectroscopic, were made by the writer.

The light curve derived from the Lick observations differs but slightly from that based on the observations made by Wen-